Kern County Water Agency
Improvement District 4
Water Quality Laboratory
Post Office Box 58
Bakersfield, California 93302-0058

Quality Assurance Manual

November 2011

Kern County Water Agency
Improvement District 4
Water Quality Laboratory

Quality Assurance Manual

This manual has been reviewed and determined to be appropriate for the scope, volume and range of analyses performed by the laboratory. This manual will be reviewed annually or more frequently as necessary. Periodic evaluations of laboratory operations will be conducted to insure that the quality control procedures and systems defined in the manual are fully implemented and adhered to at all times.

Paul Wagner
Laboratory Supervisor

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Quality Assurance Program Objectives

- Ensure that data produced by the Improvement District 4 Water Quality Laboratory is accurate and precise.

- Ensure that data produced by the Improvement District 4 Water Quality Laboratory is legally defensible.

- Ensure that the processes used by the Improvement District 4 Water Quality Laboratory to produce data are properly documented.

- Ensure that the Improvement District 4 Water Quality Laboratory is operating in accordance with federal, state and local regulations.

Quality Assurance Terminology

Terminology and definitions for quality control samples and parameters are located in the internal quality control section.

Accuracy
A combination of bias and precision of an analytical procedure which reflects the closeness of a measured value to a true value.

Bias
A consistent deviation of measured value from the true value caused by systemic errors in a procedure.

Calibration Standard
A solution containing a known concentration of method analytes, internal standard and surrogate analytes used to calibrate the instrument response with respect to the analyte concentrations in the standard.

Confidence Coefficient
The probability (percent) that a measurement result will lie within the confidence interval or between the confidence limits.

Confidence Interval
A set of possible values within which the true value will lie with a specified level of probability.

Confidence Limit
One of the boundary values defining the confidence interval.

Detection Limits
Instrumental Detection Level
The constituent concentration that produces a signal greater than five times the signal to noise ratio of the instrument. This is similar in many respects, to “Critical level” and “Criterion of detection.” The latter limit is stated as 1.645 times the standard deviation (SD) of blank analyses.

Lower level of detection
The constituent concentration in reagent water that produces a signal 2 x 1.645 x SD above the mean of blank analyses. This sets both type I and type II errors at 5%. Other names for this limit are “detection limit” and “limit of detection (LOD).”

Quality Assurance Terminology

Detection Limits (continued)

Method Detection Level

The constituent concentration that, when processed through the complete method, produces a signal with a 99% probability that it is different from the blank. For seven replicates of the sample, the mean must be 3.14 x SD above the blank where SD is the standard deviation of the seven replicates. The MDL will be larger than the LOD because of the few replications and the sample processing steps, and may vary with constituent and matrix.

Limit of Quantification

The constituent concentration that produces a signal sufficiently greater than the blank that it can be detected within specified limits by good laboratory practices during routine operations. Typically, it is the concentration that produces a signal 10 x the SD above the reagent water blank signal.

Precision

A measure of the degree of agreement among replicate analyses of a sample, usually expressed as the standard deviation.

Quality assessment

A procedure for determining the quality of laboratory measurements by use of data from internal and external quality control measures.

Quality assurance

A definitive plan for laboratory operations that specifies the measures used to produce data of known precision and bias.

Quality control

A set of measures within a sample analysis methodology to assure that the process is in control.

Random error

The deviation in any step in an analytical procedure that can be treated by standard statistical techniques.

Relative Standard Deviation

Standard Deviation, α/ Average X 100

Standard curve

A series of three or more standards or standard mixes containing the analyte(s) of interest. Each standard (mix) is run at different concentrations, from at or near the MDL to a higher level to bracket the expected concentration of the sample analyte. The resulting data generates a mathematical means for the quantification of the analyte in the samples.

Type I error

The probability of deciding a constituent is present when it actually is absent. Type I errors are also known as alpha errors.

Type II error

The probability of not detecting a constituent when it actually is present. Type II errors are also known as beta errors.

Laboratory Personnel Qualifications

Water Quality Laboratory Supervisor

1. Education and experience equivalent to a bachelor's degree in physical or natural sciences with coursework in analytical chemistry, microbiology, organic chemistry, and statistics.
2. A minimum of five years experience as a laboratory analyst in a water/wastewater laboratory.
3. Possession of a valid California Driver's license.
4. Possession of the CA/NV Section of the American Water Works Association (AWWA) Water Quality Analyst Grade 4 Certificate, or the ability to obtain the certification within 24 months.

Water Quality Laboratory Analyst II

1. Possession of an AA or AS in chemistry, biology, physics, engineering or closely related field of equivalent course of study to provide the required knowledge, skills and abilities to perform the essential functions of the job.
2. Two years experience analyzing samples in a laboratory setting.
3. Possession of a valid California Driver's license.
4. Possession of the CA/NV Section of the American Water Works Association (AWWA) Water Quality Analyst Grade 2 certification.

Water Quality Laboratory Analyst I

1. Possession of an AA or AS in chemistry, biology, physics, engineering or closely related field of equivalent course of study; or completion of two (2) years relevant course work and associated laboratory experience to provide the required knowledge, skills and abilities to perform the essential functions of the job.
2. One year of experience analyzing samples in a laboratory setting preferred.
3. Possession of a valid California Driver's license.
4. Possession of the CA/NV Section of the American Water Works Association (AWWA) Water Quality Analyst Grade 1 certification, or the ability to obtain one within 12 months of employment.

Resumes for the Water Quality Laboratory Supervisor and Water Quality Laboratory Analysts are appended. An organizational chart is also included in the appendix.

Laboratory Personnel Responsibilities

Water Quality Laboratory Supervisor

1. Ensure that data produced by the laboratory is accurate, precise and legally defensible.
2. Ensure that the processes used by the laboratory to produce data are properly documented.
3. Ensure that the laboratory is operated in accordance with federal, state and local regulations.
4. Plan, schedule and organize laboratory tasks.
5. Train and supervise laboratory technicians.
6. Institute additional analytical procedures as necessary.
7. Analyze inorganic, organic and physical samples using instrumentation and associated methods including, but not limited to, atomic absorption, gas chromatography, ion chromatography, ion selective electrodes, mass spectrometry (GC/MS), pH meter, total organic carbon analyzer, spectrophotometer and various bench and titration analyses.
8. Analyze microbiology samples using instruments and associated methods including, but not limited to, the autoclave, balances, colony counter, incubator bath, incubators, pH meter, stir/hot plate, tray sealer and UV sterilizer.
9. Perform sample preparation procedures including, but not limited to, the addition of preservation reagents, organic sample extractions and metal sample digestions.
10. Collect samples as needed from locations associated with, but not limited to, the Cross Valley Canal, distribution system, sanitary surveys, source water, treated water, treatment plant and wells.

Laboratory Personnel Responsibilities

Water Quality Laboratory Supervisor (continued)

11. Perform quality control procedures for, but not limited to, the autoclave, balances, conductivity meter, electrodes, microbiology control cultures and media, pH meter, reagents, titrants and turbidimeters.
12. Maintain all relevant quality control logs including, but not limited to, those associated with instrument temperature, reagent quality control and preparation, chain of custody, standard preparation, instrument maintenance, instrument performance checks and microbial procedures.
13. Prepare reagents, titrants, microbiology media, and other compounds, solutions and items as directed.
14. Prepare reports regarding, but not limited to, analysis summary, quality control samples, purveyor sample analysis and reports submitted for compliance purposes.
15. Maintain the inventory of all laboratory supplies and order as necessary.
16. Wash and clean laboratory bottles, containers, glassware and other items. Clean laboratory benches, cabinets, instruments, shelves, sinks and other items.
17. Perform duties relevant to water quality issues as directed.

Water Quality Laboratory Analyst II

1. Analyze inorganic, organic and physical samples using instrumentation and associated methods including, but not limited to, atomic absorption, gas chromatography, ion chromatography, ion selective electrodes, mass spectrometry (GC/MS), pH meter, total organic carbon analyzer, spectrophotometer and various bench and titration analyses.
2. Analyze microbiology samples using instruments and associated methods including, but not limited to, the autoclave, balances, colony counter, incubator bath, incubators, pH meter, stir/hot plate, tray sealer and UV sterilizer.
3. Perform sample preparation procedures including, but not limited to, the addition of preservation reagents, organic sample extractions and metal sample digestions.
4. Collect samples as needed from locations associated with, but not limited to, the Cross Valley Canal, distribution system, sanitary surveys, source water, treated water, treatment plant and wells.
5. Perform quality control procedures for, but not limited to, the autoclave, balances, conductivity meter, electrodes, microbiology control cultures and media, pH meter, reagents, titrants and turbidimeters.
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10. Wash and clean laboratory bottles, containers, glassware and other items as directed. Clean laboratory benches, cabinets, instruments, shelves, sinks and other items as directed.
11. Perform duties relevant to water quality issues as directed.

Laboratory Personnel Responsibilities

Water Quality Analyst I

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11. Perform duties relevant to water quality issues as directed.

Laboratory Safety

Safety Practices

- Concentrated acids and bases will only be handled in the fume hood.
- Safety glasses and chemical resistant gloves will be worn when handling acids, bases and reagents of any concentration.
- Chemicals from unlabeled or ambiguously labeled containers will not be used.
- Chemicals will not be tasted. Chemicals will only be smelled when absolutely necessary by cautiously wafting the vapor toward the nose while keeping the container away from the face.
- Analysts will not work alone when handling hazardous substances.
- Analysts will read the container warning label and MSDS of each chemical used in all analyses they perform.
- Hands and arms will be washed before leaving the work area and whenever a chemical contacts the skin. Hands will be sprayed with 70% ETOH after working with bacteria samples.
- Contact lenses will not be worn in the laboratory at any time.
- Long hair and loose fitting clothing will be restrained.
- Shorts, high-heeled shoes, open-toed shoes, sandals and shoes made of woven material will not be worn.
- Analysts will not eat, drink, smoke, take medication or apply cosmetics in chemical handling or storage areas.
- Analysts will not engage in horseplay, pranks and other acts of mischief in the laboratory.

Inventory of Chemicals

Chemical volumes and concentrations will be ordered and maintained at the lowest practical level. Volumes and concentrations will be limited to minimize the amount of expired chemicals, exposure of personnel to hazardous chemicals and the potential of contamination.

Storage of Chemicals

Acids, bases, and strong oxidizers will be isolated from each other and all other compounds in storage. Volatile organic solvents will be stored in the fume hood or explosion proof refrigerator. Organic and inorganic non-metal standards will also be stored in explosion proof refrigerators.

Labeling Chemical Containers

All chemical containers will be clearly labeled. Reagents prepared in the laboratory will be stored in containers labeled with the chemical name, concentration and preparation date.

Material Safety Data Sheets

Material safety data sheets (MSDS) will be maintained for each chemical used. The material safety data sheets will be stored in three ring loose-leaf binders in the laboratory. Information on the properties of chemicals can also be found on the Internet.

Safety Meetings

Safety meetings involving all treatment plant personnel will be held every two weeks. The meetings will focus on a wide range of safety topics related to the laboratory and treatment plant. A record of the meetings shall be kept in a three ring loose-leaf binder by the treatment plant safety officer.

Sampling Procedures

All samples shall be collected as specified in the following inorganic, organic, and miscellaneous sample collection and storage requirement tables.

Inorganic Sample Collection and Storage Requirements

Analyte	Container	Volume, mL	Preservative	Storage Time
alkalinity	P, G	200	None, 4ºC	14 days
aluminum	P, G	1000	HNO_3, pH < 2	6 months
ammonia	P, G	500	H_2SO_4, < 2, 4ºC	28 days
antimony	P, G	1000	HNO_3, pH < 2	6 months
arsenic	P, G	1000	HNO_3, pH < 2	6 months
barium	P, G	1000	HNO_3, pH < 2	6 months
beryllium	P, G	1000	HNO_3, pH < 2	6 months
bicarbonate	P, G	500	none, 4ºC	6 months
boron	P, PTFE cap	1000	none	6 months
bromide	P, G	100	none	28 days
cadmium	P, G	1000	HNO_3, pH < 2	6 months
calcium	P, G	1000	HNO_3, pH < 2	6 months
carbonate	P, G	500	none, 4ºC	6 months
chloride	P, G	50	none	28 days
chlorine	P, G	500	none	15 minutes
chromium VI	P, G	1000	none, 4ºC	24 hours
chromium, total	P, G	1000	HNO_3, pH < 2	6 months
cobalt	P, G	1000	HNO_3, pH < 2	6 months
color	P, G	1000	none, 4ºC	48 hours
conductivity	P, G	500	none, 4ºC	28 days
copper	P, G	1000	HNO_3, pH < 2	6 months
cyanide, total	P, G	1000	NaOH, pH > 12, 4ºC	14 days, 24 hours if sulfide present
fluoride	P	100	none	28 days
hardness	P, G	100	HNO_3, pH < 2	6 months
iron	P, G	1000	HNO_3, pH < 2	6 months
lead	P, G	1000	HNO_3, pH < 2	6 months
magnesium	P, G	1000	HNO_3, pH < 2	6 months
manganese	P, G	1000	HNO_3, pH < 2	6 months
mercury	P, G	1000	HNO_3, pH < 2	28 days
molybdenum	P, G	1000	HNO_3, pH < 2	6 months
nickel	P, G	1000	HNO_3, pH < 2	6 months
nitrate	P, G	100	none, 4ºC	48 hours, 28 days if chlorinated
nitrite	P, G	200	none, 4ºC	48 hours
odor	G	500	none, 4ºC	6 hours
oxygen, dissolved	G, BOD bottle	300	none	8 hours
perchlorate	P, G	250	none, 4ºC	28 days
pH	P, G	50	none	15 minutes
phosphate, ortho	G (A)	100	none, 4ºC	48 hours
potassium	P, G	1000	HNO_3, pH < 2	6 months
selenium	P, G	1000	HNO_3, pH < 2	6 months
silica	P, PTFE cap	200	none, 4ºC	28 days
silver	P, G	1000	HNO_3, pH < 2	6 months
sodium	P, G	1000	HNO_3, pH < 2	6 months
solids	P, G	200	none, 4ºC	7 days
sulfate	P, G	100	none, 4ºC	28 days
surfactants (MBAS)	P, G	250	none, 4ºC	6 months
temperature	P, G	none	none, 4ºC	15 minutes
turbidity	P, G	100	none, 4ºC	24 hours
thallium	P, G	1000	HNO_3, pH < 2	6 months
vanadium	P, G	1000	HNO_3, pH < 2	6 months
zinc	P, G	1000	HNO_3, pH < 2	6 months

Sampling Procedures

Organic Sample Collection and Storage Requirements

Analyte	Container	Volume, mL	Preservative	Storage Time
EPA 502.2	G	2 X 40 VOC	25 mg ascorbic acid if chlorinated, HCl, pH < 2, 4ºC	14 days
EPA 504	G	2 X 250	$Na_2S_2O_3$, 4ºC	28 days
EPA 505	G	1000	none, 4ºC	7 days
EPA 507	G	1000	none, 4ºC	7 days
EPA 508	G	1000	none, 4ºC	7 days
EPA 515.1	G	1000	none, 4ºC	7 days
EPA 524.2	G	2 X 40 VOC	25 mg ascorbic acid if chlorinated, HCl, pH < 2, 4ºC	14 days
EPA 525	G	1000	none, 4ºC	7 days
EPA 531	G, amber	250	chloroacetic buffer/$Na_2S_2O_3$, 4ºC	7 days
EPA 547	G, amber	250	$Na_2S_2O_3$, 4ºC	7 days
EPA 548.1	G	1000	$Na_2S_2O_3$, 4ºC	7 days
EPA 549	P, amber	1000	$Na_2S_2O_3$, 4ºC	7 days
EPA 550.1	G	1000	none, 4ºC	7 days
EPA 551	G	4 X 40 VOC	0.1 mL NH_4Cl, HCl, pH 4.5, 4ºC	14 days
EPA 552	G	250	0.25 mL NH_4Cl, 4ºC	28 days
EPA 632	G	1000	none, 4ºC	7 days
carbon, total organic	G, amber	2 X 40 VOC	H_2SO_4, pH < 2, 4ºC	28 days
dioxin	P, G	2 X 1000	$Na_2S_2O_3$, 4ºC	30 days
oil and grease	G(wide), amber	1000	H_2SO_4, pH < 2, 4ºC	28 days
phenols	P, G PTFE cap	500	H_2SO_4, pH < 2, 4ºC	28 days

Asbestos, Bacteriological, and Radionuclide Sample Collection and Storage Requirements

Analyte	Container	Volume, mL	Preservative	Storage Time
asbestos	P, G	1000	none, 4ºC	48 hours
bacteriological	P, G sterile	100	$Na_2S_2O_3$, 4ºC	8 hours
radionuclides	P	1000/analyte	none, 4ºC	6 months

Sample Containers

Bacteriological: Clean, sterile, 125 mL wide mouth polypropylene bottles

Metals: Clean, acid-rinsed, amber, borosilicate or polypropylene containers with TFE closures.

Mineral and Physical: Clean, amber, borosilicate glass or polypropylene bottles with TFE closures.

Purgeable VOC's: 40 mL amber, borosilicate vials with new TFE faced silicon septa

Non-purgeable Organics: Clean, amber, glass containers with new TFE closures.

Sampling Quality Control Procedures

Field reagent blanks will accompany all volatile organic chemical samples collected in the field and will be carried through the entire sampling, storage, and laboratory procedure for all analyses. All sample preservatives will be added to the field reagent blanks prior to sample collection.

Duplicate samples will be collected and analyzed to determine the precision associated with sample collection, preservation, storage and laboratory procedure.

Sampling Procedures

Chain of Custody

All sample containers will be numbered and the number will correspond to specific locations as listed in the site-sampling plan. When samples are collected from locations other than those listed in the site-sampling plan, the container will be numbered and labeled with the following information:

Sample location – address or location at which the sample is taken.
Sample source – source water description.
Time and date sample is collected.
Name of the sample collector.

The chain of custody will receive a laboratory number that will be recorded in the chain of custody logbook along with the date and time the samples were received by the laboratory. A copy of the results will be attached to the chain of custody and the chain of custody will be filed in chronological order.

Analytical Procedures

Methods

The Kern County Water Agency (KCWA), Improvement District 4 (ID4), Water Quality Laboratory primarily utilizes analytical methods published in *Standard Methods*, *20th edition* (SM) and by the Environmental Protection Agency (EPA). All samples analyzed for compliance purposes will utilize methods approved by the Environmental Laboratory Accreditation Program. The analytes and associated analysis methods are listed in the tables below.

Inorganic Nonmetallic Methods

Analyte	Method
Alkalinity	SM 2320 B
Ammonia	SM 4500-NH3 F
Bromide	EPA 300.0
Chlorate	EPA 300.0
Chloride	EPA 300.0
Chlorite	EPA 300.0
Chlorine	SM 4500-Cl G
Dissolved oxygen	SM 4500-O G
Fluoride	SM 4110 B, SM 4500-F C
Hardness	SM 2340 C
Nitrate	EPA 300.0
Nitrite	EPA 300.0
Phosphate	EPA 300.0
Silica	SM 4500-Si D
Sulfate	EPA 300.0

Analytical Procedures

Metal Methods

Analyte	Method
Aluminum	EPA 200.9
Antimony	SM 3113 B
Arsenic	SM 3113 B
Barium	SM 3113 B
Beryllium	SM 3113 B
Cadmium	SM 3113 B
Calcium	SM 3111 D
Chromium	SM 3113 B
Copper	SM 3111 B
Iron	SM 3111 B
Lead	SM 3113 B
Magnesium	SM 3111 B
Manganese	SM 3111 B
Mercury	SM 3112 B
Nickel	SM 3113 B
Potassium	SM 3111 B
Selenium	SM 3113 B
Silver	SM 3113 B
Sodium	SM 3111 B
Thallium	EPA 200.9
Zinc	SM 3111 B

Microbiological Methods

Analysis	Method
Total coliform	SM 9221 A, B, C SM 9222 A, B, C SM 9223
Fecal coliform	SM 9221 A, B, E SM 9222 D
Escherichia coli	SM 9221 A, B, C SM 9222 A, B, C SM 9223
Heterotrophic bacteria	SM 9215 B
Biochemical identification	API 20E

Organic Methods

Analyte	Method
DBCP/EDB	EPA 504.1
Haloacetic acids	EPA 552.3
Organohalide Pesticides & PCBs	EPA 505
Trihalomethanes	EPA 524.2
Total organic carbon	SM 5310 C
Dissolved organic carbon	SM 5310 C
UV254	SM 5910 B
Volatile organic chemicals	EPA 524.2

Analytical Procedures

Physical Properties Methods

Analyte	Method
Color	SM 2120 B
Conductivity	SM 2510 B
Corrosivity	SM 2330 B
Odor	SM 2150 B
pH	SM 4500-H^+ B
Temperature	SM 2550 B
Suspended solids	SM 2540 D
Total dissolved solids	SM 2540 C
Total solids	SM 2540 B
Turbidity	SM 2130 B

Samples requiring analyses not performed by the KCWA ID4 Water Quality Laboratory will be contracted out to laboratories certified by the California Department of Public Health (CDPH).

Instrumentation

General Chemistry

Equipment	Manufacturer	Model
balance – analytical	Mettler	AE 260
balance – top loading	Mettler	BB2440
stir plate	Corning	PC 210
stir plate with light	Thermolyne	7200
water bath	Blue	WB1120A

Inorganic Nonmetallic

Equipment	Manufacturer	Model
ion chromatograph	Dionex	DX600
pH/ion selective meter	Orion	720A
spectrophotometer – chlorine	Hach	Pocket Colorimeter
spectrophotometer – UV/Vis	Hach	DR4000U

Metals

Equipment	Manufacturer	Model
atomic absorption spectrometer	Perkin – Elmer	AAnalyst800
flow injection mercury system	Perkin – Elmer	FIMS 400
water bath	Blue	WB1120A

Instrumentation

Microbiology

Equipment	Manufacturer	Model
autoclave	Market Forge	Sterilmatic
colony counter	Darkfield Quebec	3325
hot/stir plate	Corning	PC 520
hot/stir plate	VWR	630 Standard
incubator – fecal coliform	Thermolyne	37900
incubator – total coliform	VWR	3015
microscope – binocular	Spencer	-
microscope – dissecting	Spencer	-
oven – hot air sterilizing	VWR	1325F
sealer – Quantitray	IDEXX	2X
sterilizer – UV	Millipore	-
UV lamp	Spectroline	EA160
water bath	Precision Scientific	66885

Organics

Equipment	Manufacturer	Model
auto sampler – GC/MS	Varian	Archon
auto sampler – GC/MS	CTC Analytics	CombiPal
gas chromatograph	Varian	3800
mass spectrometer	Varian	Saturn 2000
sample concentrator – GC/MS	Tekmar Dohrman	3100
total organic carbon analyzer	Tekmar Dohrman	Phoenix 8000
muffle furnace	Thermolyne	1400

Physical Properties

Equipment	Manufacturer	Model
conductivity meter	Orion	153A
color comparator	Hellige	611-A
turbidimeter	Hach	2100AN

Personnel Training

Laboratory staff will be trained on each instrument by the installer. Additional training at the manufacturer's school will be provided on some instruments to staff who will then train other laboratory employees.

Manufacturer's Manuals

The manufacturer's manuals will be used for training and reference, and will be kept in the laboratory library.

Instrument Inspection, Calibration and Service

Instrument	Inspection	Calibration*	Service Frequency
atomic absorption spectrometer	each use	each use	as needed
autoclave	each use	each use	as needed
balance – analytical	each use	quarterly	annually
balance – top loading	each use	quarterly	annually
gas chromatograph	each use	each use	as needed
incubators	daily	twice daily	as needed
ion chromatograph	each use	each use	as needed
mass spectrometer	each use	each use	as needed
ovens	each use	quarterly	as needed
pH/ion selective meter	each use	each use	monthly
spectrophotometer – UV/Vis	each use	each use	as needed
total organic carbon analyzer	each use	each use	as needed

*Continuing calibration checks (CCCs) will be analyzed to determine if an instrument requires recalibration.

Calibration Procedures

Atomic Absorption Spectrometer

The direct concentration calibration method will be used whenever possible. Standard addition calibration will be used for some graphite furnace analyses when matrix effects or background indicate a need. All calibration curves will consist of three to five standards, depending on the analysis method requirement. The calibration standards will bracket the expected analyte concentration. If the sample concentration is below the detection limit, the lowest calibration standard should be at the DLR.

Gas Chromatograph

Internal and external standard calibration methods with three to five standards will be used, depending upon the analysis method requirement. The lowest standard must approach the method detection limit.

Gas Chromatograph/Mass Spectrometer with Purge and Trap

The internal standard calibration method with five standards will be used. The instrument must pass the BFB tuning procedure before the analysis of the calibration standards can begin. The lowest standard must approach the method detection limit.

UV/Vis Spectrophotometer

The direct concentration method with three to five standards bracketing the expected analyte concentration will be used, depending on the analysis method requirement. The spectrophotometer will be zeroed before the first calibration standard and a procedural blank will be analyzed periodically to confirm the instrument is zeroed.

UV/persulfate TOC analyzer

The direct concentration method with five standards bracketing the expected analyte concentration will be used. The lowest standard must approach the method detection limit. The analyzer priming and cleaning procedure will be performed prior to instrument zeroing and analysis of the first calibration standard.

Instrument Inspection, Calibration and Service

Calibration Frequencies

Instruments will be recalibrated if the calibration verification standard recovery deviates from the known concentration in excess of the analysis method recovery requirement. Calibration verification standards will be analyzed prior to the analysis of samples, after every ten or twenty samples (depending upon the analysis method) and at the end of the analysis run. The concentration of the calibration verification standards will be no greater than one half of the highest calibration curve standard.

Absorbance Monitoring

Absorbance values from atomic absorption and UV/Vis spectrophotometer analyses will be monitored at each calibration. Trends in the absorbance values of the low calibration standard for each analyte will be monitored as a check on instrument performance.

Instrument Service and Preventative Maintenance

Minor repairs and routine instrument maintenance will be performed by laboratory personnel in accordance with the manufacturers' instructions. Manuals specifying service procedures are available for every instrument. Service technicians will perform repairs laboratory personnel are not capable of performing. A replacement parts inventory will be maintained for each instrument in order to minimize instrument downtime.

Internal Quality Control

Quality Control Samples and Parameters

The quality control requirements of each analysis method are specified in their respective SOPs. The terminology and associated definitions used to describe the method quality control requirements are listed below.

Initial Calibration Check
A solution containing a known concentration of method analytes used to evaluate the performance of an instrument relative to a defined set of method criteria. The initial calibration check should be analyzed immediately following instrument calibration.

Continuing Calibration Check
A calibration standard containing the method analytes, internal standard(s) and surrogate standard(s) which is analyzed periodically to verify the accuracy of the existing calibration for the method analytes.

Continuing Calibration Blank
An aliquot of reagent water prepared in exactly the same manner as the reagent water used for the preparation of the calibration standards. The continuing calibration blank is used as a zero standard and to auto-zero the instrument, or to determine if analyte carryover is occurring.

Quality Control Sample
A laboratory reagent blank or sample matrix fortified with a solution of method analytes of known concentrations. The quality control sample (QCS) must be prepared from an external laboratory source not used for the preparation of calibration standards. The purpose of the QCS is to verify laboratory performance relative to externally prepared standards and solutions.

Internal Quality Control

Quality Control Samples and Parameters

(continued)

Detection Limit for Purposes of Reporting
A calibration standard prepared at the concentration of the lowest calibration standard. The purpose of the detection limit for purposes of reporting (DLR) is to verify the accuracy of the calibration curve at the minimum reporting limit. The DLR must contain all method analytes, internal standard(s) and surrogate standard(s).

Field Reagent Blank
An aliquot of reagent water or other blank matrix that is treated exactly as a sample including shipment to the sampling site, exposure to sampling site conditions, storage, preservation and all analytical procedures. The purpose of the field reagent blank is to determine if method analytes or other interferences are present in the field environment.

Laboratory Reagent Blank
An aliquot of reagent water or other blank matrix that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards and surrogates that are used in the preparation and analysis of samples. The purpose of the laboratory reagent blank is to determine if method analytes or other interferences are present in the laboratory environment, reagents or apparatus.

Laboratory Fortified Blank
An aliquot of reagent water or other blank matrix to which known concentrations of the method analytes are added in the laboratory. The laboratory fortified blank must be analyzed exactly like a sample and its purpose is to determine if the methodology is in control and whether the laboratory is capable of making accurate and precise measurments.

Matrix Spike
An aliquot of an environmental sample to which known concentrations of the method analytes are added in the laboratory. The matrix spike (MS) must be analyzed in exactly the same manner as the samples. The purpose of the MS is to determine if the sample matrix contributes bias to the analytical results.

Matrix Spike Duplicate
Two aliquots of the same environmental sample to which known concentrations of the method analytes are added in the laboratory. The matrix spike duplicate (MSD) must be analyzed in exactly the same manner as the samples. The purpose of the MSD is to determine if the sample matrix contributes bias to the analytical results and to assess method precision and accuracy.

Duplicate Sample
Two aliquots of the same sample collected in the laboratory or field and analyzed separately using an identical analysis method. The purpose of the duplicate sample is to assess the precision of the laboratory analysis procedure.

Surrogate Standard
A pure analyte added to a sample prior to extraction or other processing for the purpose of monitoring method performance with each sample. A known concentration of the surrogate standard (SS) must be added to each sample and the SS must not be a method analyte.

Internal Quality Control

Quality Control Samples and Parameters

(continued)

Internal Standard

A pure analyte added to a sample, extract or standard solution for the purpose of measuring the relative responses of the other analytes and surrogates that are components of the same sample or solution. A known concentration of the internal standard (IS) must be added to each solution and the IS must not be a method analyte.

Control Charts

Control charts for every analyte will be maintained for continuing calibration check, duplicate sample, detection limit for purposes of reporting, laboratory fortified matrix and quality control samples. The control charts will specify mean recovery, upper control limits, and lower control limits. Upper and lower control limits for external reference samples may be the same criteria recommended by the supplier of the reference sample.

Anion-Cation Balance

An anion-cation balance will be calculated quarterly on the major ionic species for source and treated water. The typical criteria for acceptance are listed below.

Anion Sum, meq/L	Acceptable Difference
0 – 3.0	+/- 0.2
3.0 – 10.0	+/- 2%
10.0 - 800	5%

Conductivity

A logbook will be maintained for weekly checks of specific conductivity. The conductivity meter will be calibrated prior to measuring the conductivity of samples. Three KCl standard solutions will be prepared. The conductivity meter will be calibrated on the middle conductivity standard and correction factors will be calculated for the high and low standards. The middle conductivity standard will approach the expected conductivity of the samples.

Ion Specific Electrodes

The slope of the ion specific electrode will be recorded on every analysis batch summary sheet. The acceptance criteria for the electrode slope will be 57 mV +/- 3 mV.

Microbiology

Control Cultures

An ATCC registered control culture will be maintained for the following cultures:

Escherichia coli (positive for TC, FC, *E. coli*)
Klebsiella pneumonia (negative for FC)
Enterobacter aerogenes (negative for FC)
Pseudomonas aeruginosa (negative for TC)
Staphylococcus aureus (negative for TC)

The control cultures will be transferred monthly to new plate count agar slant tubes. The control culture species shall be verified quarterly using API 20E identification tests.

Internal Quality Control

Microbiology
(continued)

Incubators
All incubator temperatures will be recorded twice each day. The temperatures shall not vary by more than +/- 0.5 ºC from the method specified temperatures.

Media Preparation
All media will be prepared in strict adherence to the manufacturers' instructions. The pH of the media will be taken after sterilization and recorded in the media logbook along with the preparation details. Expiration dates and dates opened will be marked on all media containers and recorded in the media logbook.

The sterility of every batch of media shall be verified by incubating an aliquot of the media for the required period and examining it for growth. Every batch of media will also be inoculated with control cultures to ensure the media produces the appropriate response. The positive and negative controls for each media type are specified in the table below.

Media Control Cultures

Media	Positive Control	Negative Control
brilliant green bile broth	Escherichia coli	Pseudomonas aeruginosa
Colilert	*Escherichia coli*	*Pseudomonas aeruginosa*
EC medium with MUG	*Escherichia coli*	*Enterobacter aerogenes*
m endo agar LES	*Escherichia coli*	*Pseudomonas aeruginosa*
m FC agar	*Escherichia coli*	*Klebsiella pneumonia*
lauryl tryptose broth	*Escherichia coli*	*Pseudomonas aeruginosa*
nutrient agar with MUG	*Escherichia coli*	*Klebsiella pneumonia*
plate count agar	*Escherichia coli*	*Pseudomonas aeruginosa*
tryptic soy broth	*Escherichia coli*	N/A

Methods

Enzyme Substrate Test
The enzyme substrate test will be the principal method used in the analysis of all treated and source water samples. Enzyme substrate analyses will be performed using Colilert media and vessels purchased from IDEXX. Each lot of Colilert will be inoculated with *Escherichia coli*, *Klebsiella pneumonia,* and *Pseudomonas aeruginosa* to verify the media produces the appropriate response.

Heterotrophic Plate Counts
The bacterial density should be no greater than 300 bacteria per plate. A media blank plate and an air control plate will be analyzed in each batch of samples. The air control plate will remain uncovered and exposed for 15 minutes. The number of colony forming units must not exceed 15. A dilution water plate will be analyzed if samples are diluted. All plate count samples will be analyzed in duplicate.

Internal Quality Control

Microbiology
(continued)

Membrane Filtration
The membrane filtration method will be used to analyze treated and source water in the event the enzyme substrate method cannot be performed. The membrane bacterial density should be no greater than 80 coliform bacteria or 200 colonies of all types. Ten mL of dilution water will be added to the filter apparatus prior to filtering samples of 10 mL or less. The filter apparatus will be disinfected in the UV box after the filtration of each sample. A dilution water blank will be analyzed every 10 samples. All membrane filtration samples will be analyzed in duplicate.

Multiple Tube Fermentation
The multiple tube fermentation method will be used to analyze source water in the event the enzyme substrate method cannot be performed. Source water samples will be analyzed using 3 sets of 5 tubes containing 10mL, 1 mL, and 0.1 mL of media respectively. Positive and negative control cultures will be incubated with every batch of samples analyzed in EC with MUG media.

Sterilization

The sterilization times and maximum temperature shall be recorded for every autoclave run. A maximum temperature thermometer will be used to measure the temperature.

Vessels containing microbiological analysis media will be autoclaved for 15 minutes at 121ºC and 15 psi. The sterilization process will be confirmed whenever media is prepared (or monthly if multiple media batches are prepared during the month) by autoclaving a vial containing *Bacillus stearothermophilus* with the media and incubating it at 55 +/- 0.5ºC for 48 hours. Sterilization is confirmed if the vial does not change color or exhibit growth.

All sample bottles for microbiological analyses will be autoclaved for 15 minutes at 121ºC and 15 psi. The bottles will contain sodium thiosulfate prior to sterilization.

Waste will be autoclaved for a minimum of 30 minutes at 121ºC and 15 psi.

Sterility Verification

The sterility of every lot of each item, media batch or dilution water must be verified. The sterility verification procedures are listed in the table below. The absence of growth in the tryptic soy broth following incubation indicates that the item or dilution water is sterile. The sterilization of microbiological media is confirmed if the *Bacillus stearothermophilus* vial does not change color or exhibit growth following incubation.

Item	Procedure	Incubation
bacteria sample bottle	add 50 mL TSB x 1 to bottle	$\geq$ 24 hours at 35 +/- 0.5ºC
dilution water	remove 50 mL of 100 mL dH_2O in bottle add 50 mL TSB x 2 to remaining 50 mL dH_2O in bottle	$\geq$ 24 hours at 35 +/- 0.5ºC
membrane filter & pads	place item in sterile bottle add 100 mL TSB x 1 to sterile bottle containing filter	$\geq$ 24 hours at 35 +/- 0.5ºC
microbiological media	autoclave *Bacillus stearothermophilus* vial with media	$\geq$ 48 hours at 55 +/- 0.5ºC
Petri dish	add 5 mL TSB x 1 to Petri dish	$\geq$ 24 hours at 35 +/- 0.5ºC
pipette and pipette tips	induct TSB x 1 to capacity of pipette or tip discharge TSB in pipette or tip into sterile Petri dish	$\geq$ 24 hours at 35 +/- 0.5ºC
Quantitray	add 100 mL TSB x 1 to quantitray	$\geq$ 24 hours at 35 +/- 0.5ºC

Internal Quality Control

Microbiology
(continued)

Water Suitability and Inhibitory Residue Tests
The Water Suitability test and Inhibitory Residue test will be performed once each year as specified by *Standard Methods*, 20th edition.

pH Electrodes
A logbook will be maintained for pH electrode calibrations. The acceptance criteria for the electrode slope will be 100 +/- 10% (or as recommended by the manufacturer) for a two-point calibration consisting of pH 7.0 and pH 10.0 buffer solutions.

Pipettes – Adjustable
A logbook will be maintained for the monthly adjustable pipette calibration check. Each adjustable pipette will be tested at its lowest, middle and top operating range. Appropriate aliquots of dH_2O will be used to determine if the pipettes are in calibration. Pipettes determined to be out of calibration will be recalibrated following manufacturer's instructions.

Thermometers
A logbook will be maintained for the annual thermometer calibration check. Each thermometer will be checked against a certified NIST calibrated thermometer. A correction factor will be calculated for each thermometer if necessary. The correction factor will be recorded in the logbook and also affixed to the thermometer.

Turbidimeters
A logbook will be maintained for the weekly turbidimeters calibration check using 2 Gelex secondary standards. The acceptance criteria will be +/- 5% of the value of the secondary standards as measured immediately after the monthly calibration of the turbidimeters. The turbidimeters will be calibrated more frequently if the calibration check falls outside the acceptance criteria.

Apparatus and Reagent Quality Control Monitoring Schedule

Each Use
pH meter calibration

Weekly
conductivity meter accuracy check
eye wash station flush
reagent preparation
turbidimeter accuracy check

Internal Quality Control

Apparatus and Reagent Quality Control Monitoring Schedule

(continued)

Monthly

autoclave sterility check
balance accuracy check
chloride electrode calibration (operations laboratory)
control culture transfer
pipette accuracy check
quantitray sealer
water quality check (dH_2O & RO)
titrant accuracy check
turbidimeter calibration

Quarterly

autoclave timer check

Biannually

control culture rehydration
control culture API 20E identification

Annually

thermometer accuracy check

Logbooks

The following logbooks will be maintained to record instrument parameters, standard preparation, reagent preparation and reagent quality control.

1. Instrument Temperature Log:
   - incubator (total coliform)
   - incubator (fecal coliform)
   - refrigerator
   - autoclave
   - sterilization oven
   - fecal coliform waterbath

2. Instrument and Reagent Quality Control Log:
   - alkalinity
   - chloride
   - hardness
   - DI/RO system
   - gas inventory
   - hood velocity
   - autoclave timer
   - balances
   - thermometers
   - spectrophotometer (standard absorbance test)

Internal Quality Control

Logbooks
(continued)

3. Instrument Calibration Log:
   - conductivity meter
   - pH electrode
   - turbidimeter calibration check
   - turbidimeter calibration

4. Instrument Maintenance Logs

5. Microbiological Quality Control Log:
   - Colilert reagent
   - sterility (dilution water and vessels)
   - autofluorescence
   - quantitray sealer
   - media preparation
   - control cultures

6. Reagent Preparation Log

7. Metal Sample Digestion Log

8. Haloacetic Acid Sample Digestion Log

9. Atomic Absorption Standard Preparation Log

10. Colorimetric and Selective Ion Electrode Standard Preparation Log

11. Ion Chromatography Standard Preparation Log

12. Organic Standard Preparation Log

Data Reduction and Validation

Significant Figures

All digits in a reported result are expected to be known definitely, except for the last digit, which may be in doubt. If more than a single doubtful digit is carried, the extra digit(s) is not significant.

Reported figures will be determined by the accuracy of the work. Digits that are not significant or known definitely will be dropped. If the digit 6, 7, 8, or 9 is dropped, the preceding digit will increase by one unit. If the digit 0, 1, 2, 3, or 4 is dropped, the preceding digit is not altered. If the digit 5 is dropped, the preceding digit is rounded off to the nearest even number. The digit 0 may record a measured value or it may serve as a spacer to locate a decimal point.

Data Reduction and Validation

Units

The International System of Units (SI) will be used to report most results. However, terms such as ppm and acre-feet will occasionally be used. Concentration units will be expressed as indicated in the table below.

Referent	Abbreviation
grams per liter	% or g/L
milligram per liter	mg/L
microgram per liter	µg/L
nanogram per liter	ng/L
Nephelometer turbidity units	NTU
colony forming units	cfu
part per million	ppm
part per billion	ppb
part per billion	ppt

Data Reduction

Data generated by the mass spectrometer, gas chromatograph, total organic carbon analyzer, high-pressure liquid chromatograph and atomic absorption spectrometer will be acquired and reduced by the instrument's software. The software will be capable of accounting for diluted samples. Data generated by the UV/Vis spectrometer and pH/ion electrode will be recorded by hand and processed using software programs such as Curve and CCPro. The data systems will be able to generate the following data:

Response/Calibration Factors
Correlation Coefficient
Variance
Linear and quadratic best fit
Maximum, minimum, and average
Control charts

Raw data includes: handwritten and printed measured values, dilution and concentration factors, sample treatment and calculations.

Finished data includes: chromatograms, calibration curves, and computerized or handwritten analysis summary reports. All pertinent raw data will be attached to the corresponding finished report.

Data Validation

All analytical results will be reviewed prior to reporting. The review process will include but not be limited to: condition of sample, adherence to established standard operating procedures, verification of calculations and comparison of the new quality control data against established control charts.

Reporting

Final reports will be submitted only when all relevant data has been reduced, reviewed and validated. All reports submitted for compliance with CDPH regulations will be completed and submitted by the tenth day following the end of the monitoring period. Completion of compliance monitoring reports will take priority over all other reports.

Report and Record Archival

Records of all verbal and written water quality and system water outage complaints received will be retained for a period of five years. The records will also include any corrective action taken.

Records of all bacteriological analyses will be retained for a minimum of the most recent five years.

Records for all chemical analyses will be retained for a minimum of the most recent ten years.

All records will contain the following information:

- Sample date, place, and time
- Sample collector
- Sample identification (include sample type for bacteria samples)
- Date of report
- Name of the laboratory
- Name of the analyst or laboratory director
- Analytical technique or method
- Analysis results

Records and resultant corrective actions will be retained for a minimum of three years following the final action taken to correct a particular violation.

Records of any type relating to sanitary surveys of the system conducted by the water supplier, a private consultant, or any local, state or federal agency will be retained for a minimum of ten years following completion of the sanitary survey involved.

Variances or exemptions granted to the laboratory will be retained for a minimum of five years following the expiration of the variance or exemption.

Performance and System Audits

Laboratory Check Samples

Laboratory check samples purchased from vendors such as ERA and NSI will be analyzed quarterly. The analyte recovery will be within the acceptance range specified by the manufacturer. The check samples shall consist of regulated and unregulated analytes representative of the following classes of constituents:

1. inorganic metallics
2. inorganic non-metallics
3. purgeable organics
4. non-purgeable organics

Laboratory Intercomparison Samples

The laboratory will analyze performance evaluation samples annually as required by the Environmental Laboratory Accreditation Program. The samples will consist of metals, non-metals, organics and bacteria. The samples will encompass every method the laboratory is certified to perform.

Compliance Audits

The collection, storage and analysis of specific analytes and methods will be periodically observed to verify adherence to the appropriate SOP.

Performance and System Audits

Laboratory Quality Systems Audits

Internal quality systems audits will be conducted annually to assess the quality assurance process. The internal audit will examine the entire spectrum of procedures and policies associated with sample processing, sample analysis, data reduction and reporting. Environmental Laboratory Accreditation Program inspectors will conduct audits to assess the quality assurance process every other year.

Corrective Actions

Corrective actions will be implemented as soon as possible after the discovery of a deficiency. SOPs and policies will be updated and discussed with laboratory and treatment plant staff as necessary. Corrective action responses will be submitted to the Environmental Laboratory Accreditation Program as required.

Quality Assurance Reports

Quality assurance reports will include but not be limited to quality control charts, standard operating procedures and corrective action responses. Quality control charts will be updated and reviewed periodically. All quality control charts will be available for inspection by authorized personnel. Written standard operating procedures (SOPs) will be maintained for every method performed by the laboratory. The SOPs will be periodically reviewed and revised if deficiencies are discovered. Corrective action responses will be compiled addressing deficiencies discovered by the Environmental Laboratory Accreditation Program (ELAP) inspectors. The corrective action responses will be forwarded to ELAP and Agency management for review.

Traceability

All measurements will be made utilizing calibration standards and calibration check standards prepared in accordance with National Institute of Standards and Technology guidelines. The certificate of analysis for each calibration standard and calibration check standard will be kept on file for the duration of the measurement archival period. Standard preparation logbooks will be maintained listing the log number, concentration, expiration date and required dilutions for each analysis batch. The standard preparation logbooks will also be kept on file for the duration of the measurement archival period. All reagents used will be of American Chemical Society grade or better.

Procurement

All purchases of instrumentation and operating supplies will be made in accordance with the Kern County Water Agency's Purchasing Policies Interpretation and Procedures Manual.